Cost of Energy and Machine Scale Assessment

Alan Laxson, NREL/NWTC

2005 Program Implementation Meeting

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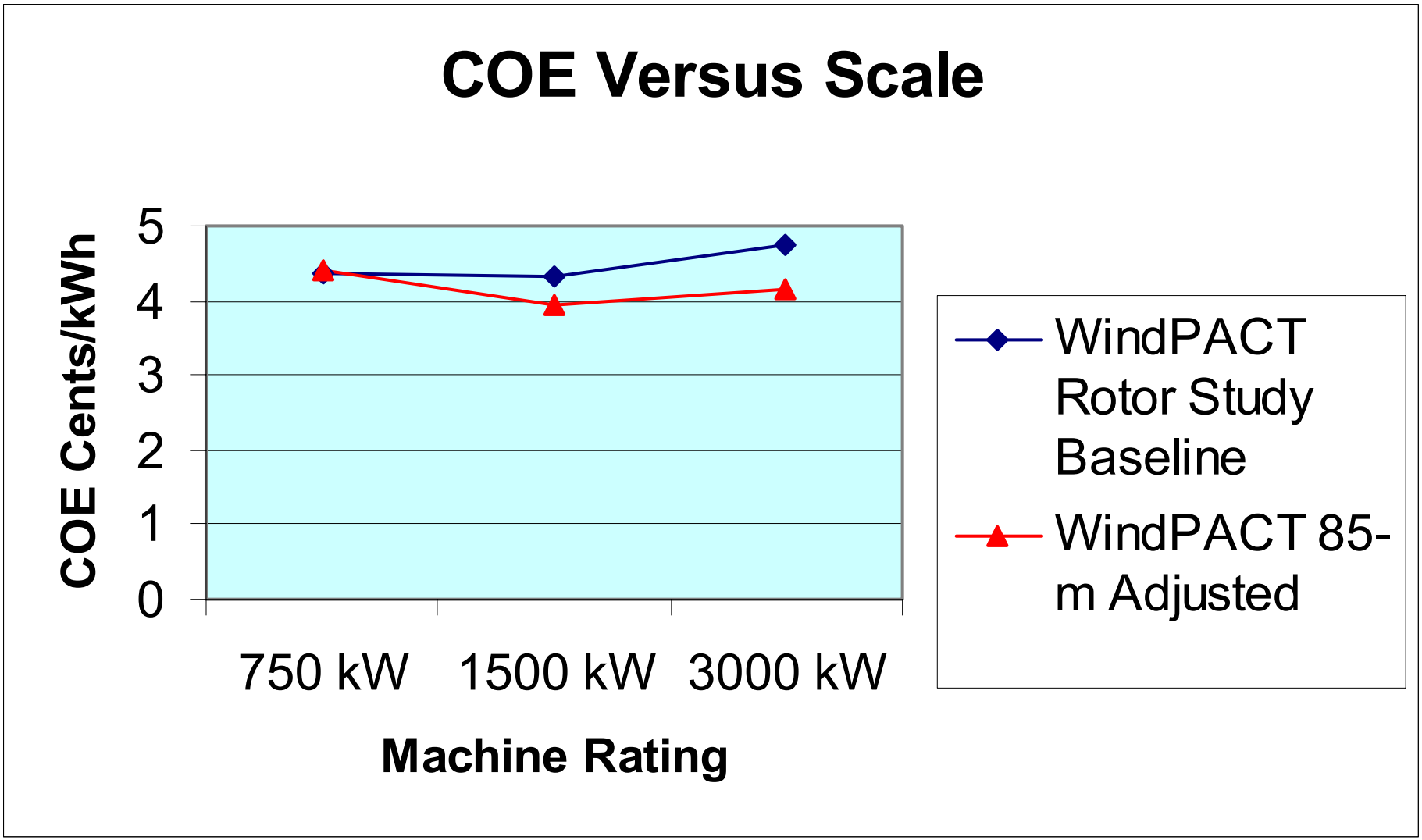
Cost of Energy by Rating



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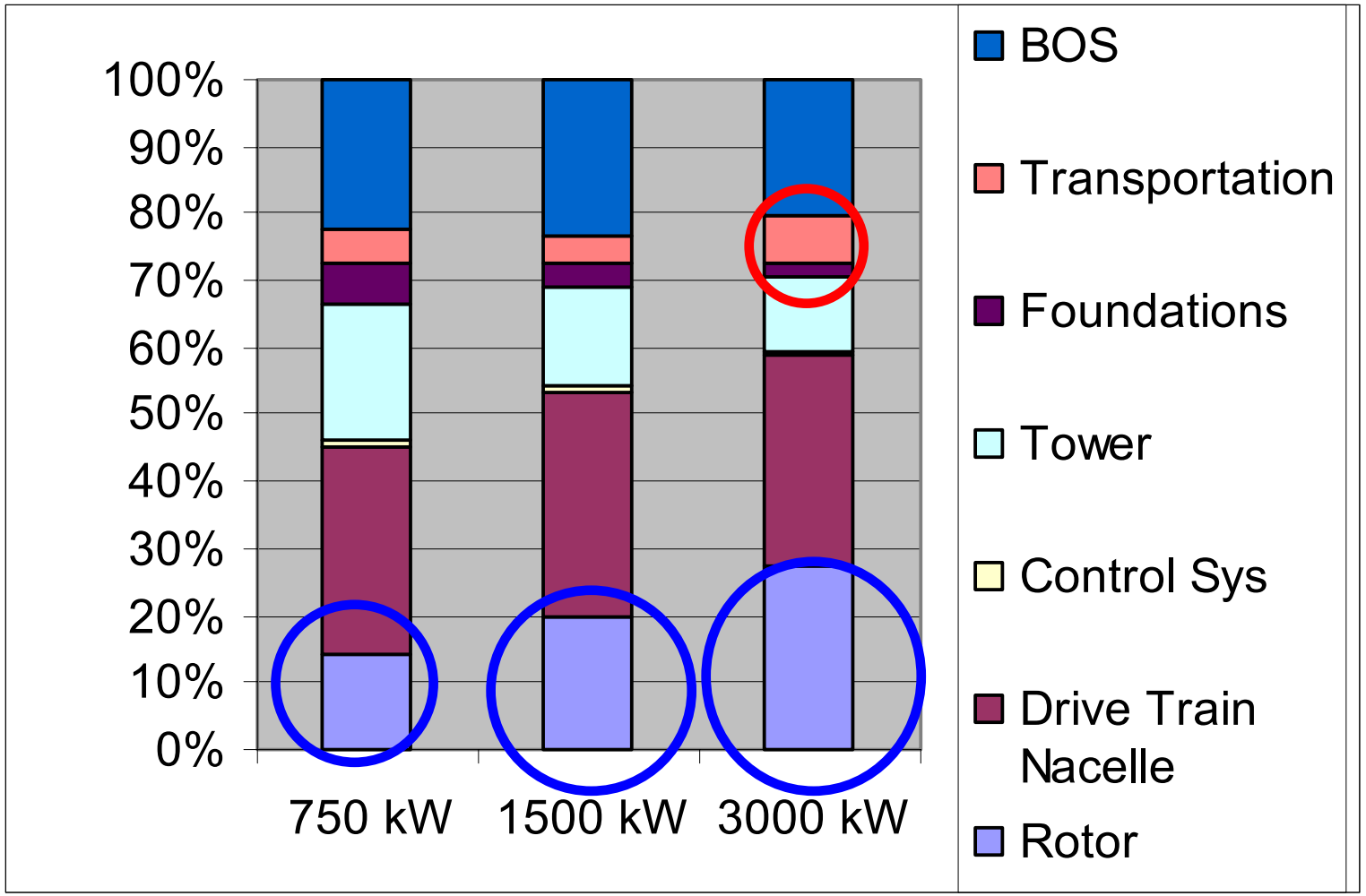
Major Capital Cost Categories



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COE Size Impactors

- Rotor Cost
- Transportation Cost
  - Rotor
  - Tower
  - Drive Train
- Secondary
  - Tower Weight & Cost
  - Erection Cost

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Rotor Costs Reductions

- Susceptible to New Structural Designs Allowing Rotor Growth at Less than Cubic
  - Flatback Airfoils (Greater Inboard Airfoil Thickness for Improved Structural Performance)
  - Advanced Composite Materials (Carbon, S - Glass)
- Susceptible to Advanced Manufacturing
  - Onsite Manufacturing
  - Segmented Blades

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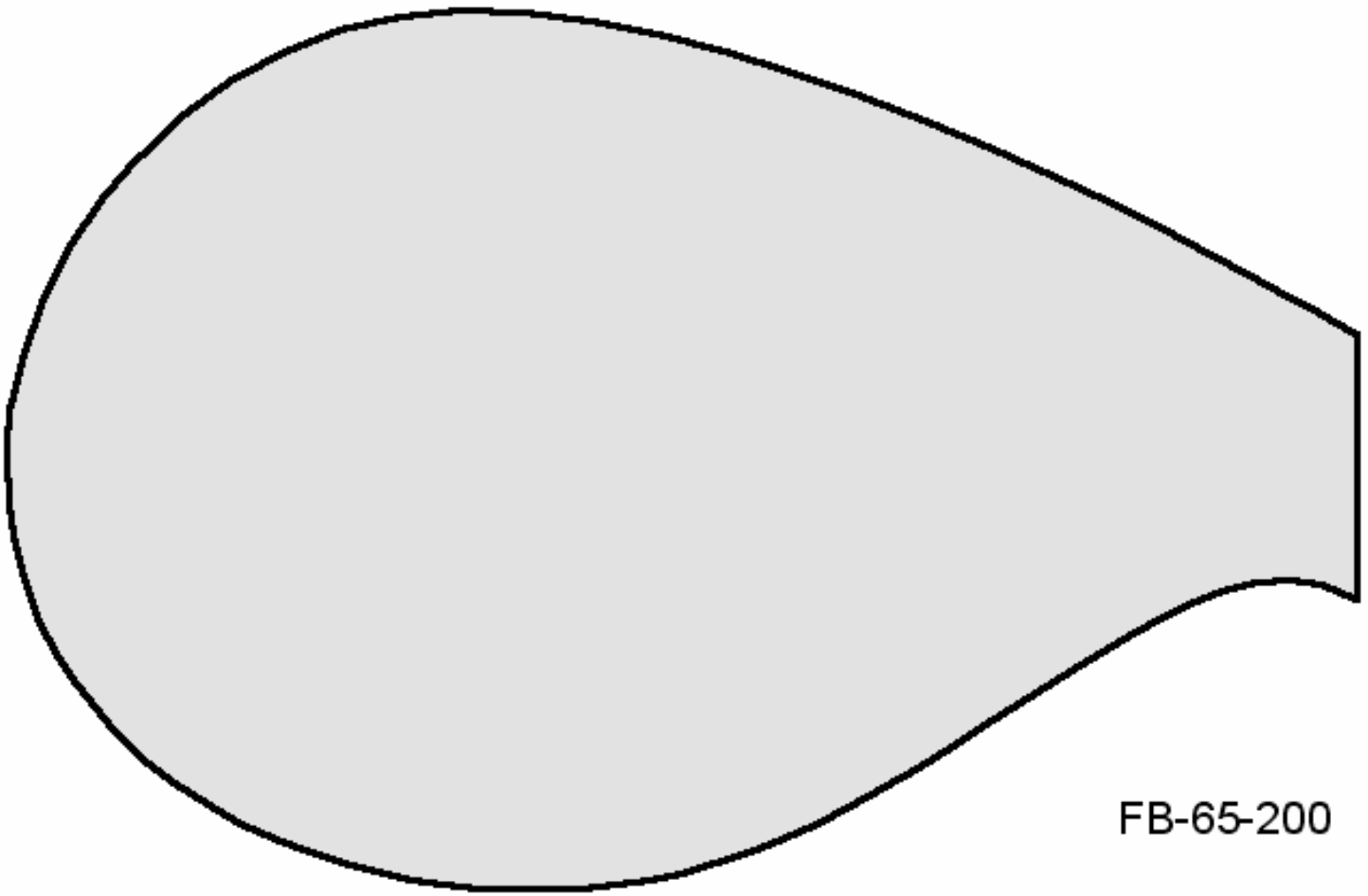
New Airfoil Designs



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Transportation Cost Reductions

- Onsite Fabrication of Tower
- Onsite Fabrication or Segmented Blades
- Lighter Weight and More Compact Drive Trains
- Designers of New Machines Already Playing at the Edge of the Envelope

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Advanced Towers Reduce Transport Costs

- Self Erection – Greater Tower Heights with Reduced Crane Costs
- New Materials – Composites
- Innovative Structures – Onsite Forming, Modular Onsite Fabrication, Space Frame Structures

Vestas V66 on 117 m tower

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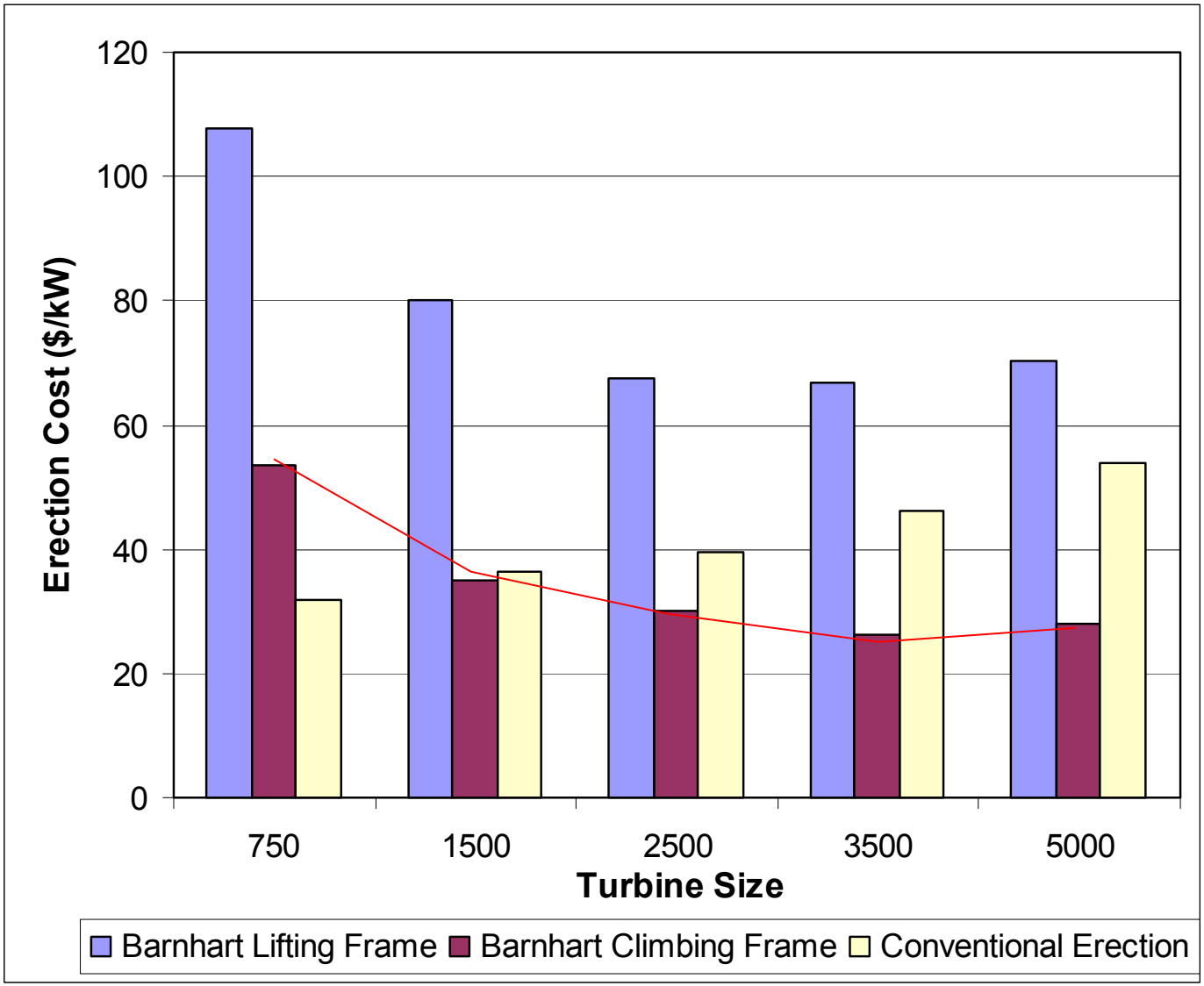
Cost Impact of Erection Modes



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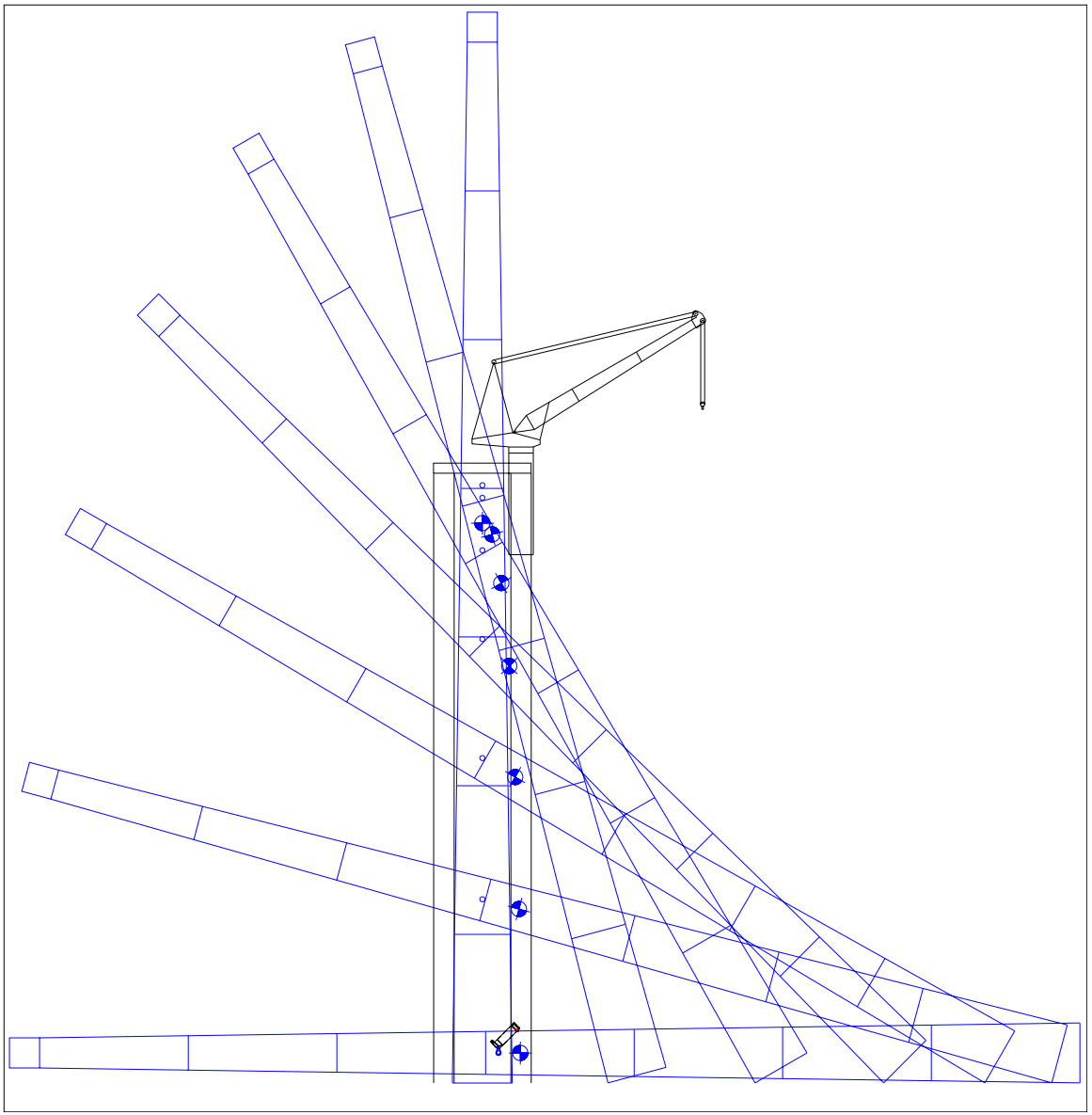
Barnhart Lifting Frame



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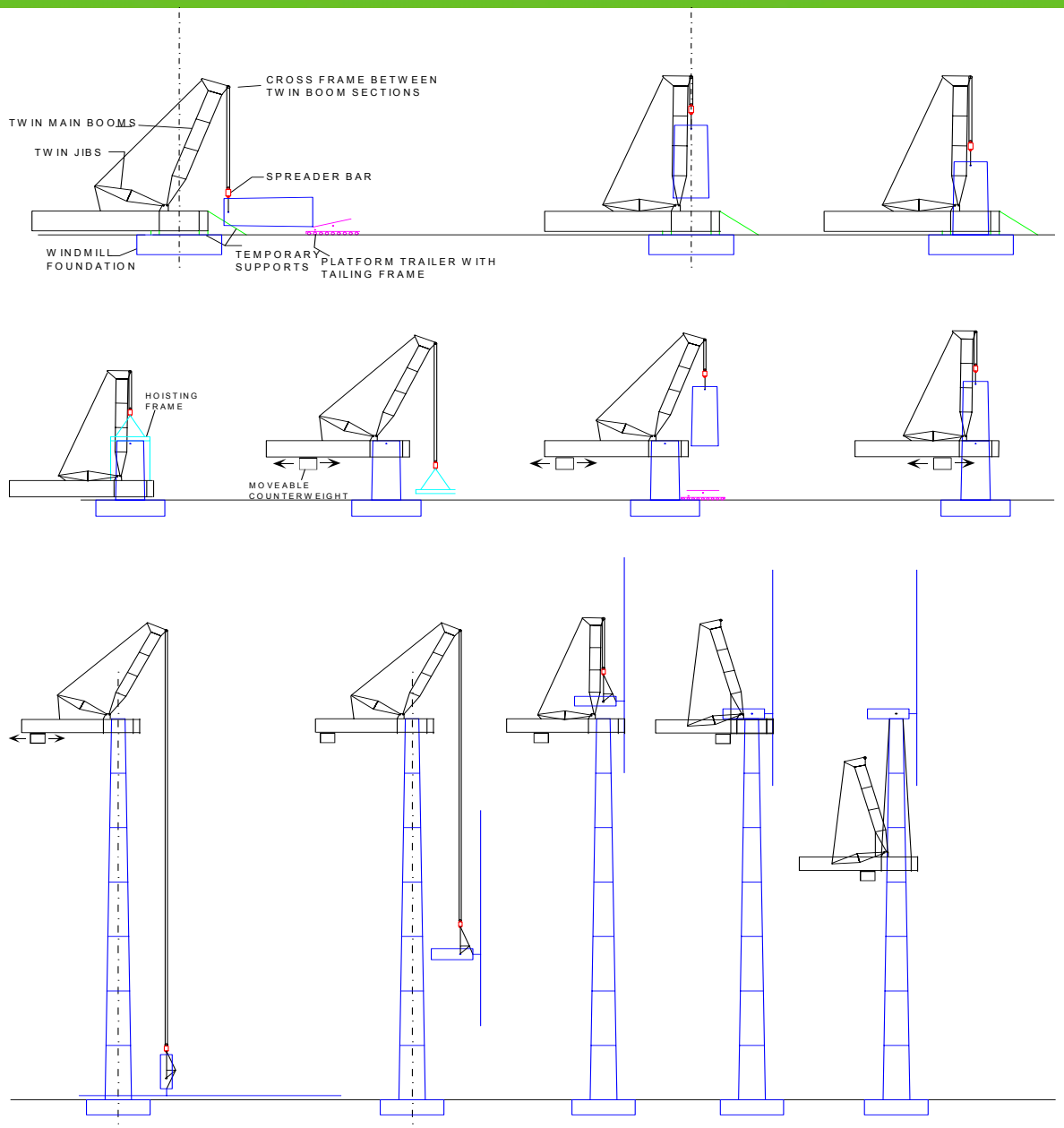
Barnhart Climbing Frame



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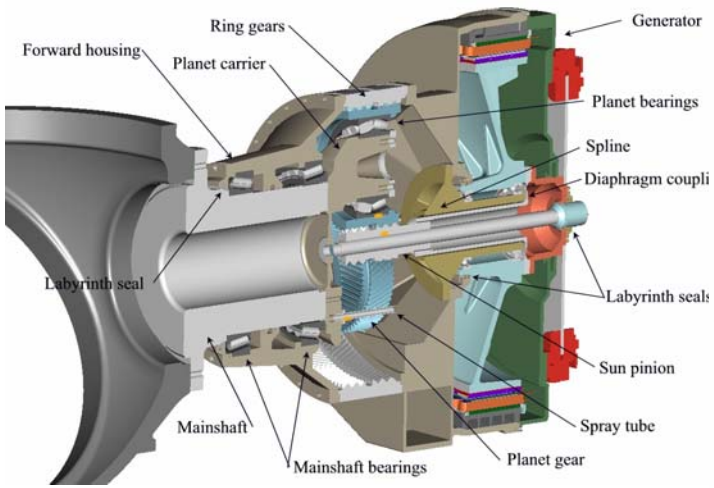
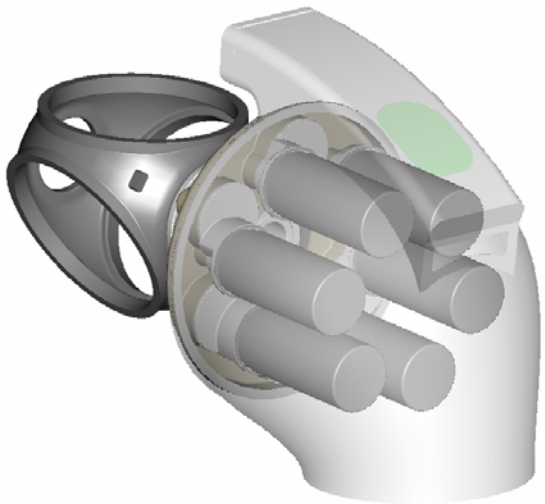
New Drive Train Concepts

- **New Designs Allow Larger Machines While Limiting Weight and Mass - Decreases Transportation and Erection Costs**
- **PM Generators**
  - Takes Advantage of Falling Costs of Rare Earth Permanent Magnets
  - PM Designs Lighter and Smaller By Removing Mass of Copper in Rotor





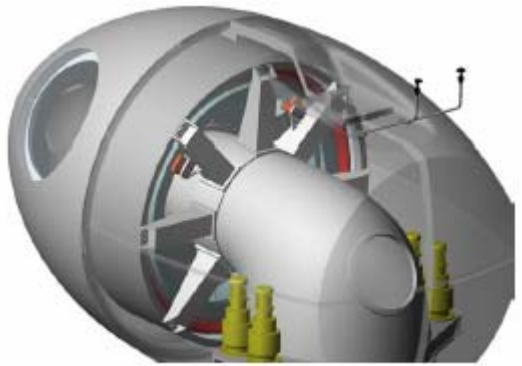


Figure 7-7. PMDD drivetrain

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Why Bigger Offshore

- Cost of Foundation is Only Slightly Impacted by Size
- Cost Effective to Put Largest Rotor Possible to Take Advantage of Foundation Cost
- Transportation and Erection Costs Less of Impact on Size Offshore Due to Availability of Larger Transport and Erection Equipment

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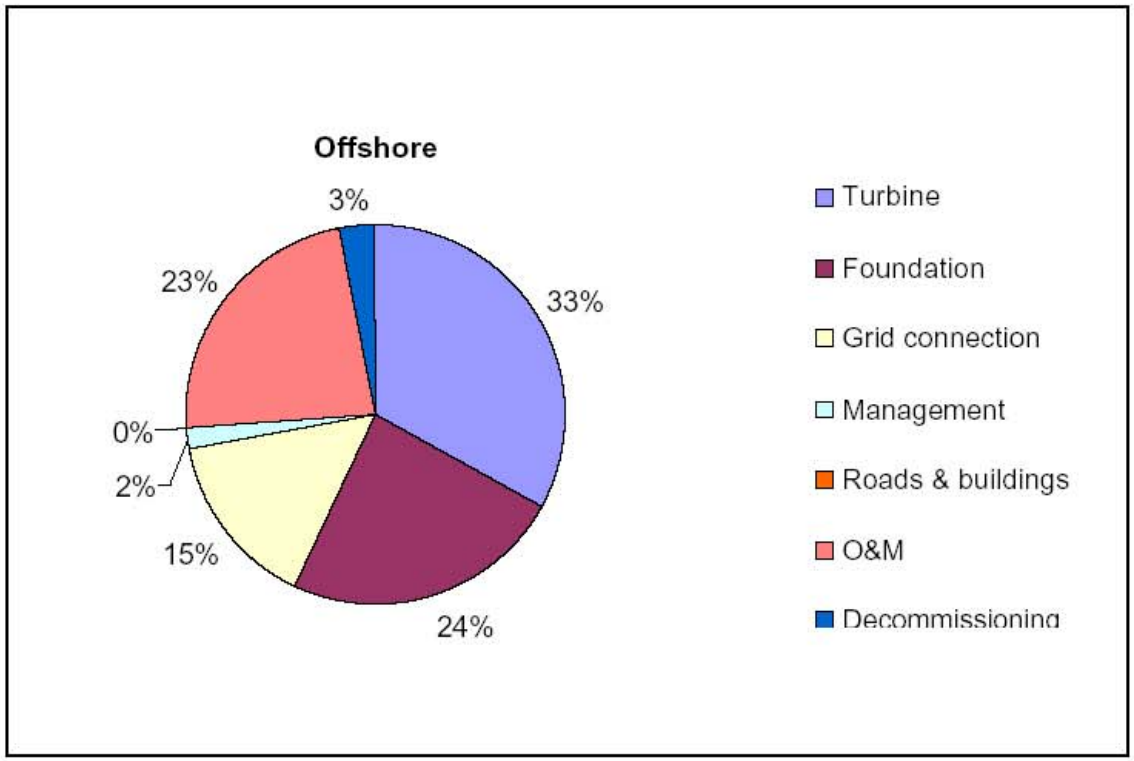
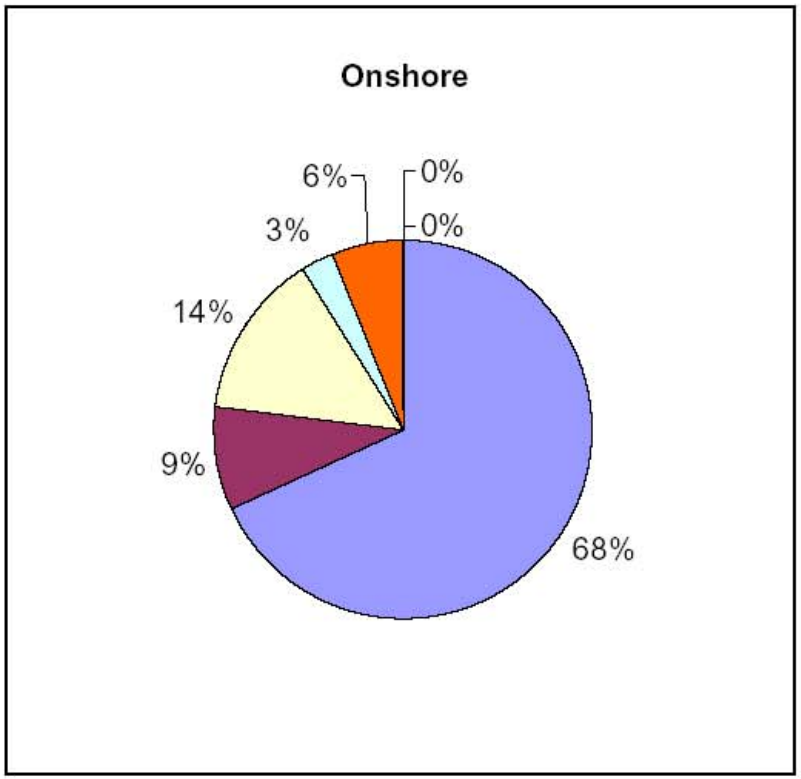
Onshore Vs Offshore





Costs range from 2000eur/kW to 1500eur/kW

Horns Rev ~ 1700eur/kW

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